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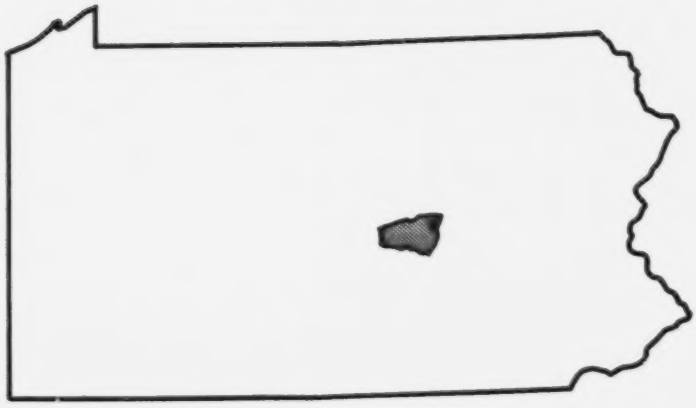
ORIGINAL

FLOOD INSURANCE STUDY

TOWNSHIP OF UNION, PENNSYLVANIA
SNYDER COUNTY



MAY 17, 1982

Federal Emergency Management Agency

COMMUNITY NUMBER - 422040

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PUBLISHED SEPARATELY:

Flood Insurance Rate Map Index

Flood Insurance Rate Map

FLOOD INSURANCE STUDY
TOWNSHIP OF UNION, PENNSYLVANIA

1.0 INTRODUCTION

1.1 Purpose of Study

This Flood Insurance Study investigates the existence and severity of flood hazards in the Township of Union, Snyder County, Pennsylvania, and aids in the administration of the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973. This study will be used to convert Union to the regular program of flood insurance by the Federal Emergency Management Agency (FEMA). Local and regional planners will use this study in their efforts to promote sound flood plain management.

In some states or communities, flood plain management criteria or regulations may exist that are more restrictive or comprehensive than those on which these federally-supported studies are based. These criteria take precedence over the minimum federal criteria for purposes of regulating development in the flood plain, as set forth in the Code of Federal Regulations at 44 CFR, 60.3. In such cases, however, it shall be understood that the state (or other jurisdictional agency) shall be able to explain these requirements and criteria.

1.2 Authority and Acknowledgements

The source of authority for this Flood Insurance Study is the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973.

The hydrologic and hydraulic analyses for this study were prepared by Bourquard and Berger Associates for the Federal Emergency Management Agency, under Contract No. H-4763. This work was completed in April 1980.

1.3 Coordination

In May 1978, streams requiring detailed and approximate study were identified at an initial Consultation and Coordination Officer's (CCO) meeting attended by representatives of the FEMA, the Township of Union, and Bourquard and Berger Associates (the study contractor). Follow-up contacts were made with community officials and several residents who live along the streams in November and December 1979.

Personal visits were made to offices of the Baltimore District of the U. S. Army Corps of Engineers (COE), the Susquehanna River Basin Commission, the Soil Conservation Service (SCS), the U. S. Geological

Survey (USGS), and the Pennsylvania Department of Environmental Resources to obtain available information pertinent to this study. Results of the hydrologic analyses were coordinated with all agencies which were visited. On December 7, 1981, the results of the study were reviewed at a final CCO meeting held with representatives of the FEMA, the township, and the study contractor.

2.0 AREA STUDIED

2.1 Scope of Study

This Flood Insurance Study covers the incorporated area of the Township of Union, Snyder County, Pennsylvania. The area of study is shown on the Vicinity Map (Figure 1).

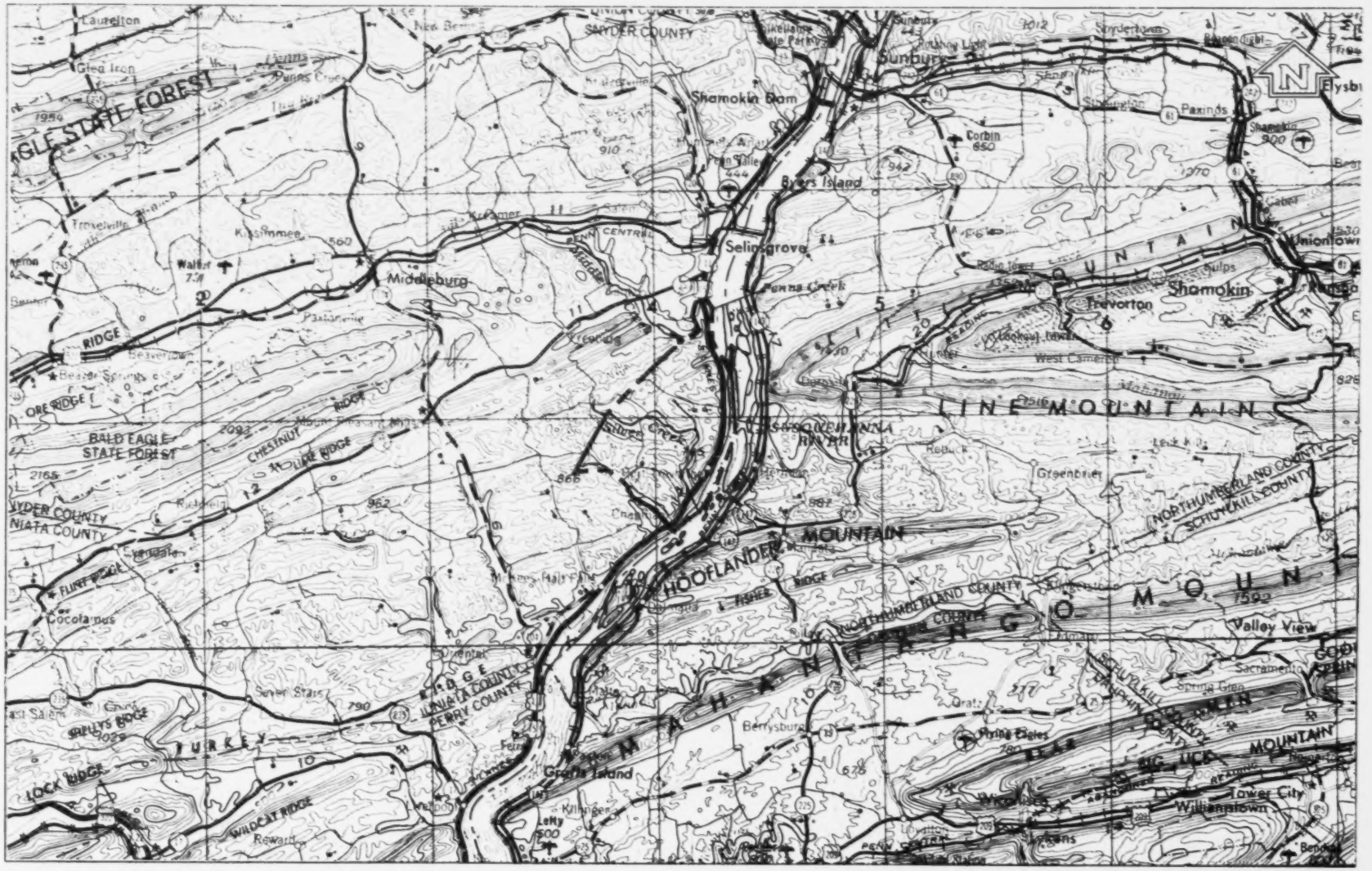
The Susquehanna River, Penns Creek, Middle Creek, and Silver Creek from its confluence with the Susquehanna River to a point approximately 1,155 feet upstream of Legislative Route 54071 were studied by detailed methods. The areas studied by detailed methods were selected with priority given to all known flood hazard areas and areas of projected development and proposed construction for the next five years, through April 1985.

Chapman Creek and the remaining portion of Silver Creek were studied by approximate methods. Approximate methods of analysis were used to study those areas having low development potential and minimal flood hazards as identified at the initiation of the study. The scope and method of study were proposed to and agreed upon by the FEMA.

2.2 Community Description

Union is located in the southeastern portion of Snyder County in central Pennsylvania, approximately 30 miles north of the City of Harrisburg. It is bordered by the Townships of Lower Augusta and Jackson to the east, the Township of Penn to the north, the Township of Washington to the west, and the Townships of Chapman and Lower Mahanoy to the south. Union is primarily rural and undeveloped. The population increased from 1,235 in 1970 to an estimated 1,374 in 1975, an increase of 11.2 percent (References 1 and 2).

Union was settled in 1766 and incorporated on May 26, 1869, after being a part of the Township of Chapman (Reference 3). Situated in the Appalachian Ridge and Valley province of Pennsylvania, the Union encompasses an area of 13.9 square miles (Reference 2). The topography consists mainly of forested mountains and rolling agricultural valleys. Most residential development is of the scattered array type. Commercial development is of the same form and primarily serves the immediate needs


SNYDER COUNTY
Sunbury
Shamokin Dam
Selinsgrove
Middleburg
Shamokin
Trevorton
Paxinos
Union
Valley View
Berrysburg
Green Island
Williamstown
Lower City
Greenbrier
Cocolamus
Spring Glen
Sacramento
Reward
Lehy
Killinger
Corbin
650
Penns Creek
Penns Creek
Walker
Kissimmee
Beaver Springs
Richfield
Laurelton
Glen Iron
Troxelville
Swineford
Snydertown
Flysburg
Paxinds
Shamokin
Union
Sulps
Rising Sun
Rising Eagles
Sylvan Dale
Lower City
Williamstown
Benton
Orbisonia
Mount Pleasant Mills
Richfield
Selinsgrove
Middleburg
Shamokin
Trevorton
Sunbury
Berrysburg
Green Island
Valley View
Lower City
Williamstown
Benton
Orbisonia
Mount Pleasant Mills
Richfield
Laurelton
Glen Iron
Troxelville
Swineford
Snydertown
Flysburg
Paxinds

of the residents. Access to the township is provided by State Routes 11 and 15. A machinery factory and a travel trailer-camper plant are the only industries in Union (References 2, 4, and 5).

The climate of Union is generally continental, but is modified by the effects of the Atlantic Ocean and the Gulf of Mexico. The average annual temperature is approximately 50 degrees Fahrenheit. The annual precipitation averages about 41 inches annually and is normally well distributed throughout the year (References 4 and 5).

The Susquehanna River and Penns Creek flow south along the eastern boundary of the township. The confluence of these two streams is in the northernmost point of Union. Middle Creek flows east along the northern corporate limits to its confluence with Penns Creek. Silver Creek flows east through the southern portion of the township to its confluence with the Susquehanna River.

Most of the areas along these streams are undeveloped; however, there are significant pockets of development, especially along the Susquehanna River and Silver Creek. The development includes commercial, agricultural, and residential use.

2.3 Principal Flood Problems

The history of flooding within Union indicates that flooding can occur during any season of the year. Flooding from localized thunderstorms is more severe on small tributaries similar in drainage size to those of the approximate study streams. On the average, 41 thunderstorms occur annually, with 60 percent occurring in summer, 25 percent in spring, 14 percent in fall, and 1 percent in winter (References 4 and 5). These localized thunderstorms produce flooding on the smaller streams, such as Silver Creek, and even those having relatively large drainage areas such as Middle Creek and Penns Creek. However, floods on the Susquehanna River result from much larger area-wide storms, such as Tropical Storm Agnes which occurred in June 1972. In fact, flooding sometimes occurs on the river when the smaller streams experience only minor rises.

Although there are no gages on the Susquehanna River at Union, historical and systematic records obtained from the USGS for the nearest river gage at Sunbury, Pennsylvania, indicate that there have been four major floods on the Susquehanna River during the last 100 years in the reach between Juniata River and Penns Creek, which includes Union. The floods, in order of decreasing magnitude, included on June 24, 1972, March 19, 1936, May 29, 1946, and March 11, 1964. The June 1972 flood had a recurrence interval between 100 and 500 years when the Susquehanna River water-surface profiles are compared to the June 1972 high-water mark profile (Reference 6).

The USGS gaging station (No. 5550) at Penns Creek, Pennsylvania, measures the flow of water from a 301-square mile portion of the Penns Creek watershed. However, the streamflow records of this station are not particularly applicable to flood hazards in the portion of Penns Creek in Union since the township reach is immediately upstream of the confluence with the Susquehanna River and flooding results more from river backwater than from the creek flows.

There are no stream gage records on Middle Creek to provide a direct history of flooding on this stream. It is known that Middle Creek experienced major flooding in 1889, 1927, 1933, 1936, 1942, 1952, 1956, and 1972 (Reference 7). According to hydrologic analysis of rainfall records and stream gage records in adjacent areas, the large flood of June 1972 had a recurrence interval greater than the 500-year flood on Middle Creek. A comparison of water-surface profiles with high-water marks obtained from residents who live along Silver Creek indicates that the June 1972 flood fell between the 100- and 500-year floods.

2.4 Flood Protection Measures

Eleven upstream dams contribute to the reduction of flood hazard from the Susquehanna River, including four in the West Branch Susquehanna River subbasin. Flood hazard reduction in the West Branch Susquehanna River subbasin is aided by: Blanchard Dam, located about 12 miles southwest of Lock Haven, Pennsylvania, on Bald Eagle Creek; Stevenson Dam, located about 8 miles northeast of Sinnemahoning, Pennsylvania, on First Fork Sinnemahoning Creek; Kettle Creek Dam, located about 8 miles northeast of Westport, Pennsylvania, on Kettle Creek; and Curwensville Dam, located about 7 miles southwest of Clearfield, Pennsylvania, on the West Branch Susquehanna River.

Flood hazard reduction in the other Susquehanna River subbasins is aided by: Stillwater Reservoir, located about 9 miles north of Carbondale, Pennsylvania, on the Lackawanna River; East Sidney Lake, located about 8 miles east of Sidney, New York, on Ouleout Creek; Whitney Point Dam, located about 1 mile north of Whitney Point, New York, on the Otselic River; Almond Dam, located about 2 miles northwest of Hornell, New York, on Canacadea Creek; Arkport Dam, located about 5 miles northeast of Hornell, New York, on the Canisteo River; the Tioga-Hammond Dam complex, located 20 miles soutnwest of Elmira, New York, on the Tioga River and Crooked Creek; and the Cowanesque Lake project located on the Cowanesque River approximately 2.2 miles above the confluence with the Tioga River at Lawrenceville, Pennsylvania.

The Middle Creek watershed has been the subject of a plan for flood protection under Public Law 566 (Reference 7). This plan and amendments thereto were developed by the SCS to protect primarily the Borough of

Middleburg from damage caused by flooding from Middle Creek. Ultimately, three flood control reservoirs situated on upstream tributaries, PA-636, PA-637, and PA-638 and a dike situated in Middleburg, PA-640, will offer this protection. Flood control reservoir PA-636 will be located on South Branch Middle Creek and will control a drainage area of 33 square miles. Flood control reservoir PA-637 is located on North Branch Middle Creek and controls a drainage area of 17.6 square miles. Flood control reservoir PA-638 will be located on a small unnnamed tributary near Beavertown and will control a drainage area of 5.3 square miles. The dike will provide flood protection to Middleburg. An Environmental Impact Statement has recently been completed for the dike project.

Flood control reservoir PA-637 was built in 1970. The other components of the SCS plan have not yet been constructed and have not progressed sufficiently far enough to be considered in this Flood Insurance Study. When complete, the reservoirs will decrease peak discharges thereby reducing flood heights in Middle Creek.

There are no flood control dams within the Penns Creek watershed. However, a flood warning system was initiated in December 1978 by the Snyder County Civil Defense Agency which utilizes twelve rain gages and six stream gages in the Penns Creek and Middle Creek watersheds. This project, which is under the supervision of the Civil Defense and the County Commissioners, was accomplished through the cooperative efforts of county officials, state government agencies, and the Susquehanna University Institute of Environmental Studies. In the Penns Creek watershed, manually read stream gages are located at the bridge leading to Camp Karoundinha in western Union County, at the State Route 104 bridge near the Town of Penns Creek, and at a bridge over Penns Creek in Kratzerville. A major use of the rainfall and stream records will be to build a data base for predicting the height and timing of flood flows in the stream. The data only extends back to 1978, but as more severe floods are experienced it is expected the added information will permit the Susquehanna University of Environmental Studies to develop a usable mathematical model for flood prediction purposes. There are no flood control dams or projects within the Silver Creek watershed.

3.0 ENGINEERING METHODS

For the flooding sources studied in detail in the community, standard hydrologic and hydraulic study methods were used to determine the flood hazard data for this study. Flood events of a magnitude which are expected to be equalled or exceeded once on the average during any 10-, 50-, 100-, or 500-year period (recurrence interval) have been selected as having special significance for flood plain management and for flood insurance premium rates. These events, commonly termed the 10-, 50-, 100-, and 500-year floods, have a 10-, 2-, 1-, and 0.2-percent chance, respectively, of being equalled or

exceeded during any year. Although the recurrence interval represents the long-term average period between floods of a specific magnitude, rare floods could occur at short intervals or even within the same year. The risk of experiencing a rare flood increases when periods greater than one year are considered. For example, the risk of having a flood which equals or exceeds the 100-year flood (one-percent chance of annual occurrence) in any 50-year period is about 40 percent (four in ten) and, for any 90-year period, the risk increases to about 60 percent (six in ten). The analyses reported here reflect flooding potentials based on conditions existing in the community at the time of completion of this study. Maps and flood elevations will be amended periodically to reflect future changes.

3.1 Hydrologic Analyses

Hydrologic analyses were carried out to establish the peak discharge-frequency relationships for floods of the selected recurrence intervals for each flooding source studied in detail affecting the community.

For the Susquehanna River, a discharge-frequency relationship was obtained from the Flood Insurance Study for the Township of Jackson (Reference 8). This relationship was developed from statistical analyses performed by the COE for the stream gages at Sunbury and Harrisburg. The nearest stream gaging station is located at Sunbury approximately 6 miles upstream of the confluence of Penns Creek and the Susquehanna River in Union. This station has 43 years of systematic record and a historical record that extends back to 1865. The statistical analysis followed the standard log-Pearson Type III method (Reference 9). The resulting flood-frequency curves were adjusted for the additional downstream drainage area. The final relationship was then used without further adjustment for the entire reach of the Susquehanna River from the confluence of the Juniata River to the confluence of Penns Creek.

Discharge-frequency relationships for Penns Creek and Middle Creek were obtained from the Flood Insurance Study for the Township of Penn (Reference 10). For Silver Creek, a comparison was made of peak discharge-frequency relationships developed from applicable regional hydrologic methods (References 9, 11, 12, 13, and 14). The PSU III method, as modified by a publication by B. M. Reich, was determined to be most applicable to this watershed's characteristics (References 13 and 14).

TABLE 1 - SUMMARY OF DISCHARGES

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. miles)	PEAK DISCHARGES (cfs) 10-YEAR	50-YEAR	100-YEAR	500-YEAR
SUSQUEHANNA RIVER					
At the downstream corporate limits	19,687	342,000	490,000	575,000	840,000

TABLE 1 - SUMMARY OF DISCHARGES - continued

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. miles)	PEAK DISCHARGES (cfs) 10-YEAR	50-YEAR	100-YEAR	500-YEAR
PENNS CREEK					
At the confluence with the Susquehanna River	554	19,800	34,000	42,500	71,000
At the confluence of Middle Creek	377	13,800	22,500	28,000	44,000
MIDDLE CREEK					
At the confluence with Penns Creek	175	6,050	9,200	10,900	14,750
SILVER CREEK					
At the confluence with the Susquehanna River	5.9	1,150	1,920	2,240	2,960

Flood discharges for the streams studied by approximate methods were developed through the use of an envelope curve relating the 100-year peak discharge against their drainage areas. This curve was constructed from a graphical compilation of actual 100-year peak discharges from other Flood Insurance Studies and 100-year peak discharges developed from regional hydrologic methods (References 11, 13, and 14). The locus of peak-discharge was enveloped by a curve to provide a conservative 100-year peak discharge for the corresponding drainage area of any approximate study stream.

3.2 Hydraulic Analyses

Analyses of the hydraulic characteristics of the flooding sources studied in detail were carried out to provide estimates of the elevations of floods of the selected recurrence intervals along each of these flooding sources.

Hydraulic analyses for the Susquehanna River were obtained from the Flood Insurance Study for the Township of Jackson (Reference 8). Hydraulic analyses for Penns Creek and Middle Creek were obtained from the Flood Insurance Study for the Township of Penn (Reference 10). Cross sections for the backwater analyses of Silver Creek were obtained from aerial photographs flown in December 1978 at a scale of 1"=1,000' (Reference 15). The below-water sections were obtained by a stream bottom profile field survey. All bridges, dams, and culverts were tied into the vertical photo control base. All dimensions of structures were obtained in the field.

Water-surface elevations of floods of the selected recurrence intervals were computed using the COE HEC-2 step-backwater program (Reference 16). The acceptability of all assumed hydraulic factors, cross sections and their adjustments, ineffective flow areas, and hydraulic structure data that were used in the backwater analyses for Silver Creek was supported by high-water data obtained from residents who lived along the streams before and after the June 1972 flood. Although no specific discharges for the 1972 flood were available, a comparison of the computed profiles with the high-water marks indicated the reasonableness of the computed profiles.

Starting water-surface elevations for the Susquehanna River were obtained from the Flood Insurance Study for the Township of Jackson (Reference 8). Starting water-surface elevations for Penns Creek and Middle Creek were obtained from the Flood Insurance Study for the Township of Penn (Reference 10). Starting water-surface elevations for Silver Creek were determined using the slope/area method.

Channel roughness factors (Manning's "n") used in the hydraulic computations were chosen by engineering judgment and based on a field and aerial photograph review of the stream and overbank areas. The channel "n" values for the Susquehanna River was 0.032, and the overbank "n" values ranged from 0.065 to 0.075. The channel "n" values for Penns Creek ranged from 0.028 to 0.030, and the overbank "n" values ranged from 0.045 to 0.057. For Middle Creek, the channel "n" values ranged from 0.034 to 0.048, and the overbank "n" values ranged from 0.039 to 0.110. The channel "n" values for Silver Creek ranged from 0.040 to 0.048, and the overbank "n" values ranged from 0.043 to 0.100.

Flood profiles were drawn showing computed water-surface elevations to an accuracy of 0.5 foot for floods of the selected recurrence intervals. Locations of selected cross sections used in the hydraulic analyses are shown on the Flood Profiles (Exhibit 1). For stream segments for which a floodway is computed (Section 4.2), selected cross-section locations are also shown on the Flood Boundary and Floodway Map (Exhibit 3).

All elevations used in this study are referenced to the National Geodetic Vertical Datum of 1929 (NGVD), formerly referred to as Sea Level Datum of 1929. Locations of the elevation reference marks used in the study are shown on the maps.

The hydraulic analyses for this study are based on the effects of unobstructed flow. The flood elevations shown on the profiles are valid only if hydraulic structures remain unobstructed, and dams and other flood control structures operate properly and do not fail.

For the streams studied by approximate methods, the 100-year flood was developed using normal depth calculations.

4.0 FLOOD PLAIN MANAGEMENT APPLICATIONS

The National Flood Insurance Program encourages state and local governments to adopt sound flood plain management programs. Therefore, each Flood Insurance Study includes a flood boundary map designed to assist communities in developing sound flood plain management measures.

4.1 Flood Boundaries

In order to provide a national standard without regional discrimination, the 100-year flood has been adopted by the FEMA as the base flood for purposes of flood plain management measures. The 500-year flood is employed to indicate additional areas of flood risk in the community. For each stream studied in detail, the boundaries of the 100- and 500-year floods have been delineated using the flood elevations determined at each cross section; between cross sections, the boundaries were interpolated using topographic maps at a scale of 1"=200' with a contour interval of 5 feet (Reference 17). In cases where the 100- and 500-year flood boundaries are close together, only the 100-year boundary has been shown.

For the streams studied by approximate methods, the boundary of the 100-year flood using USGS topographic maps and data from SCS soil maps and USGS flood-prone area maps (References 18, 19, 20, and 21).

The boundaries of the 100- and 500-year floods are shown on the Flood Boundary and Floodway Map (Exhibit 3). Small areas within the flood boundaries may lie above the flood elevations and, therefore, may not be subject to flooding. Owing to limitations of the map scale and lack of detailed topographic data, such areas are not shown.

4.2 Floodways

Encroachment on flood plains, such as artificial fill, reduces the flood-carrying capacity, increases the flood heights of streams, and increases flood hazards in areas beyond the encroachment itself. One aspect of flood plain management involves balancing the economic gain from flood plain development against the resulting increase in flood hazard. For purposes of the Flood Insurance Program, the concept of a floodway is used as a tool to assist local communities in this aspect of flood plain management. Under this concept, the area of the 100-year flood is divided into a floodway and a floodway fringe. The floodway is the channel of a stream plus any adjacent flood plain areas that must be kept free of encroachment in order that the 100-year flood can be carried without substantial increases in flood heights. Minimum standards of the FEMA limit such increases in flood heights to 1.0 foot, provided that hazardous velocities are not produced. The floodways in this report are presented to local agencies as minimum standards that can be adopted or that can be used as a basis for additional studies.

The floodways presented in this study for the Susquehanna River, Penns Creek, and Middle Creek were computed on the basis of equal conveyance reduction from each side of the flood plains. The floodway adopted for Silver Creek was defined as a percentage of reduction of the conveyance, proportionally removed from the 100-year flood plain. The percentage of conveyance was developed at each section from a comparison of the 50-year and the 100-year flood conveyances. This method was selected after equal conveyance reduction method trials to minimize the delineation of the floodways of the floodways with greatly varying topwidths. The results of these computations are tabulated at selected cross sections for each stream segment for which a floodway is computed (Table 2).

As shown on the Flood Boundary and Floodway Map (Exhibit 3), the floodway widths were determined at cross sections; between cross sections, the boundaries were interpolated. In cases where the boundaries of the floodway and the 100-year flood are either close together or collinear, only the floodway boundary has been shown. The Susquehanna River, Penns Creek, and Middle Creek extend beyond the corporate limits.

The area between the floodway and the boundary of the 100-year flood is termed the floodway fringe. The floodway fringe thus encompasses the portion of the flood plain that could be completely obstructed without increasing the water-surface elevation of the 100-year flood by more than 1.0 foot at any point. Typical relationships between the floodway and the floodway fringe and their significance to flood plain development are shown in Figure 2.

Near the mouths of streams studied in detail, floodway computations are made without regard to flood elevations on the receiving water body. Therefore, "With Floodway" elevations presented in Table 2 for certain downstream cross sections of Penns Creek, Middle Creek, and Silver Creek are lower than the regulatory flood elevations in that area, which must take into account the 100-year flooding due to backwater from other sources.

5.0 INSURANCE APPLICATION

In order to establish actuarial insurance rates, the FEMA has developed a process to transform the data from the engineering study into flood insurance criteria. This process includes the determination of reaches, Flood Hazard Factors (FHFs), and flood insurance zone designations for each flooding source affecting the Township of Union.

5.1 Reach Determinations

Reaches are defined as lengths of watercourses having relatively the same flood hazard, based on the average weighted difference in water-surface

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE	WIDTH[3] (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY (FEET NGVD)	WITH FLOODWAY	INCREASE
Susquehanna River								
A	6,400[1]	4,160	97,796	5.9	421.9	421.9	422.3	0.4
B	9,720[1]	4,466	96,376	6.0	422.7	422.7	423.1	0.4
C	14,370[1]	4,626	85,347	6.7	424.3	424.3	424.6	0.3
D	18,255[1]	4,620	89,321	6.4	425.9	425.9	426.2	0.3
E	19,465[1]	3,532	84,364	6.8	426.4	426.4	426.6	0.2
F	20,680[1]	4,001	92,860	6.2	426.8	426.8	427.1	0.3
G	22,700[1]	4,279	90,380	6.4	427.4	427.4	427.7	0.3
H	24,530[1]	4,240	81,760	7.0	428.1	428.1	428.3	0.2
I	27,200[1]	5,000	91,843	6.3	429.4	429.4	429.6	0.2
Penns Creek								
A	900[2]	470	8,299	4.5	430.2	426.9[4]	427.4	0.5
B	2,070[2]	801	8,953	4.2	430.8	427.1[4]	427.6	0.5
C	3,320[2]	805	8,885	4.2	431.1	427.3[4]	427.8	0.5
D	4,460[2]	802	9,632	3.9	431.6	427.6[4]	428.3	0.7
E	5,555[2]	800	8,324	4.5	431.9	427.8[4]	428.5	0.7
F	6,335[2]	844	11,121	3.4	432.1	428.2[4]	429.0	0.8
G	7,650[2]	905	11,044	3.4	432.4	428.4[4]	429.2	0.8
H	8,450[2]	1,250	15,436	2.4	432.5	428.7[4]	429.5	0.8
I	9,065[2]	1,300	13,385	2.8	432.8	428.8[4]	429.6	0.8
J	9,775[2]	525	5,854	6.4	432.9	428.8[4]	429.6	0.8
K	9,805[2]	427	6,471	5.8	432.9	428.9[4]	429.7	0.8

[1]Feet above corporate limits (extended)
[2]Feet above confluence with Susquehanna River
[3]This width extends beyond corporate limits
[4]Elevation computed without consideration of backwater effects from Susquehanna River

TABLE 2

FEDERAL EMERGENCY MANAGEMENT AGENCY

TOWNSHIP OF UNION, PA
(SNYDER CO.)

FLOODWAY DATA

SUSQUEHANNA RIVER AND PENNS CREEK

BEST DOCUMENT AVAILABLE

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE	WIDTH[3] (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY (FEET NGVD)	WITH FLOODWAY	INCREASE
Penns Creek (continued)								
L	9,855[1]	427	6,562	5.7	432.9	429.0[4]	429.8	0.8
M	9,885[1]	429	6,706	5.6	432.9	429.0[4]	429.8	0.8
Middle Creek								
A	195[2]	187	1,393	7.8	432.8	418.7[4]	419.6	0.9
B	655[2]	219	1,729	6.3	432.8	420.6[4]	421.0	0.4
C	795[2]	193	2,081	5.2	432.8	421.0[4]	422.0	1.0
D	1,155[2]	146	1,406	7.8	432.8	421.1[4]	422.0	0.9
E	1,620[2]	330	2,491	3.7	432.8	422.5[4]	423.2	0.7
F	2,035[2]	246	2,204	4.9	432.8	422.7[4]	423.3	0.6
G	2,490[2]	248	1,927	5.7	432.8	423.1[4]	423.7	0.6
H	3,435[2]	285	1,333	8.2	432.8	424.7[4]	424.9	0.2
I	3,865[2]	152	1,745	6.2	432.8	426.8[4]	427.8	1.0
J	3,960[2]	393	2,703	4.0	432.8	427.1[4]	428.1	1.0
K	4,160[2]	343	2,410	4.5	432.8	427.2[4]	428.2	1.0
L	4,480[2]	270	4,253	2.6	432.8	428.1[4]	428.9	0.8
M	4,585[2]	412	6,235	1.7	440.8	440.8	441.6	0.8
N	5,330[2]	354	5,044	2.2	440.9	440.9	441.7	0.8
O	5,725[2]	369	5,550	2.0	440.9	440.9	441.7	0.8
P	6,275[2]	615	8,137	1.3	441.0	441.0	441.7	0.7
Q	6,805[2]	501	6,208	1.8	441.0	441.0	441.7	0.7
R	7,885[2]	440	5,175	2.1	441.1	441.1	441.8	0.7

[1]Feet above confluence with Susquehanna River
[2]Feet above confluence with Penns Creek
[3]This width extends beyond the corporate limits
[4]Elevation computed without consideration of backwater effects from Susquehanna River

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TABLE 2

FEDERAL EMERGENCY MANAGEMENT AGENCY

TOWNSHIP OF UNION, PA
(SNYDER CO.)

FLOODWAY DATA

PENNS CREEK AND MIDDLE CREEK

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
					(FEET NGVD)			
Middle Creek (continued)								
S	9,275[1]	366[3]	4,665	2.3	441.2	441.2	441.9	0.7
T	10,000[1]	529[3]	5,823	1.9	441.3	441.3	442.0	0.7
Silver Creek								
A	883[2]	67	421	5.2	421.9	416.1[4]	417.1	1.0
B	1,353[2]	61	276	7.9	421.9	417.9[4]	418.5	0.6
C	1,868[2]	123	318	6.9	423.0	423.0	423.1	0.1
D	2,848[2]	45	258	8.5	432.4	432.4	432.9	0.5
E	4,048[2]	56	256	8.6	450.9	450.9	451.0	0.1
F	4,818[2]	166	774	2.8	455.2	455.2	455.8	0.6
G	5,183[2]	41	242	9.1	456.1	456.1	456.6	0.5
H	5,633[2]	175	810	2.7	462.2	462.2	462.2	0.0
I	6,498[2]	137	320	5.7	468.5	468.5	468.6	0.1
J	7,233[2]	99	561	3.3	476.6	476.6	477.1	0.5
K	8,678[2]	107	412	4.5	487.1	487.1	487.6	0.5
L	8,953[2]	110	479	3.8	490.3	490.3	490.8	0.5
M	9,778[2]	117	254	7.2	496.9	496.9	496.9	0.0
N	11,008[2]	171	328	5.6	512.9	512.9	512.9	0.0
O	12,178[2]	124	442	4.2	521.5	521.5	521.7	0.2
P	12,798[2]	230	981	1.9	528.5	528.5	529.0	0.5
Q	13,232[2]	130	283	5.3	530.4	530.4	530.5	0.1

[1]Feet above confluence with Penns Creek

[2]Feet above confluence with Susquehanna River

[3]This width extends beyond corporate limits

[4]Elevation computed without consideration of backwater effects from Susquehanna River

TABLE 2

FEDERAL EMERGENCY MANAGEMENT AGENCY

TOWNSHIP OF UNION, PA
(SNYDER CO.)

FLOODWAY DATA

MIDDLE CREEK AND SILVER CREEK

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FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
					(FEET NGVD)			
Silver Creek (continued)								
R	14,262	116	285	5.3	539.7	539.7	539.9	0.2
S	14,982	94	890	1.7	553.5	553.5	554.3	0.8
T	16,022	170	422	3.6	556.8	556.8	556.9	0.1

[1]Feet above confluence with Susquehanna River

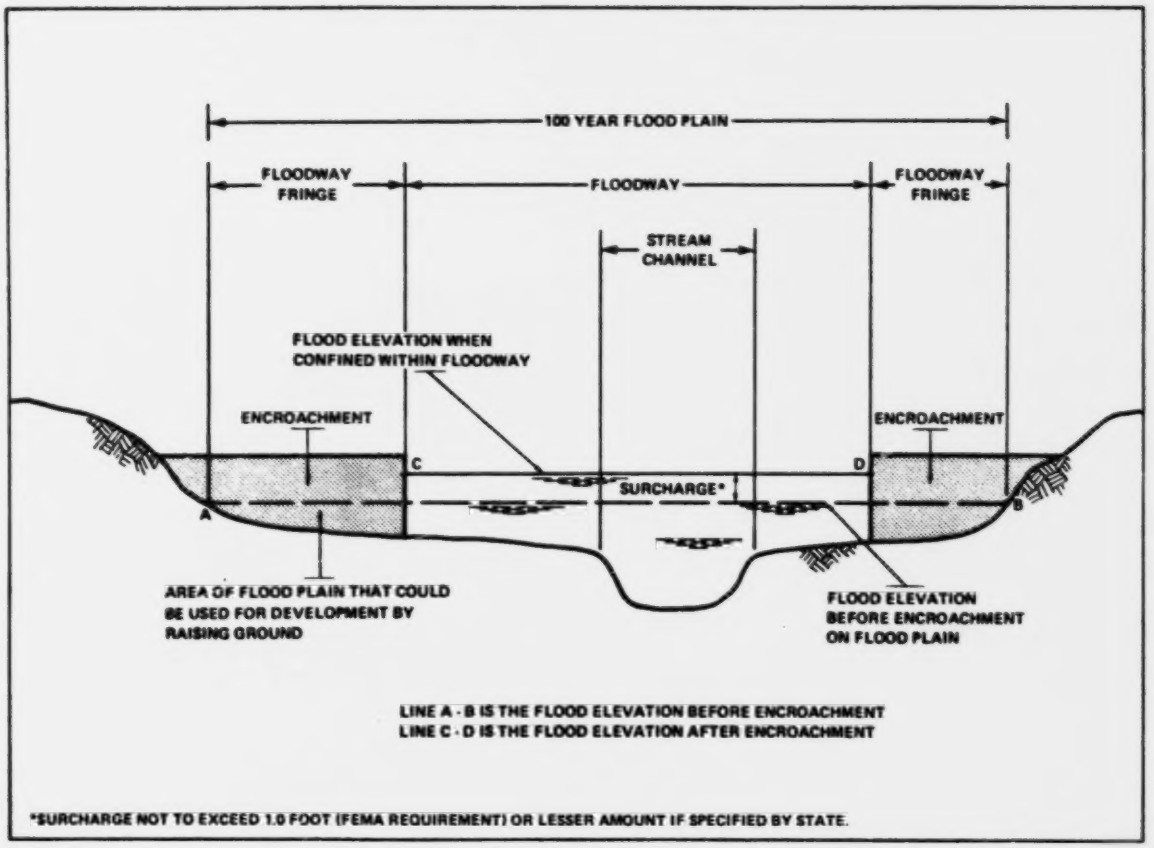
TABLE 2

FEDERAL EMERGENCY MANAGEMENT AGENCY

TOWNSHIP OF UNION, PA
(SNYDER CO.)

FLOODWAY DATA

SILVER CREEK


100 YEAR FLOOD PLAIN
FLOODWAY FRINGE
FLOODWAY
FLOODWAY FRINGE
STREAM CHANNEL
FLOOD ELEVATION WHEN CONFINED WITHIN FLOODWAY
ENCROACHMENT
ENCROACHMENT
C
D
SURCHARGE*
A
B
AREA OF FLOOD PLAIN THAT COULD BE USED FOR DEVELOPMENT BY RAISING GROUND
FLOOD ELEVATION BEFORE ENCROACHMENT ON FLOOD PLAIN
LINE A - B IS THE FLOOD ELEVATION BEFORE ENCROACHMENT
LINE C - D IS THE FLOOD ELEVATION AFTER ENCROACHMENT
*SURCHARGE NOT TO EXCEED 1.0 FOOT (FEMA REQUIREMENT) OR LESSER AMOUNT IF SPECIFIED BY STATE.

FLOODWAY SCHEMATIC - Figure 2

elevations between the 10- and 100-year floods. This difference does not have a variation greater than that indicated in the following table for more than 20 percent of the reach.

Average Difference Between 10- and 100-Year Floods	Variation
Less than 2 feet	0.5 foot
2 to 7 feet	1.0 foot
7.1 to 12 feet	2.0 feet
More than 12 feet	3.0 feet

The locations of the reaches determined for the flooding sources of the Township of Union are shown on the Flood Profiles (Exhibit 1) and are summarized in the Flood Insurance Zone Data Table (Table 3).

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FLOODING SOURCE	PANEL[1]	ELEVATION DIFFERENCE[2] BETWEEN 1.0% (100-YEAR) FLOOD AND			FHF	ZONE	BASE FLOOD ELEVATION[3] (NGVD)
		10% (10 YR.)	2% (50 YR.)	0.2% (500 YR.)			
Susquehanna River							
Reach 1	05	-6.1	-1.9	+4.5	060	A12	Varies
Reach 2	01,03,05	-6.4	-2.0	+4.5	065	A13	Varies
Middle Creek							
Reach 1	01	-1.6	-0.4	+1.1	015	A3	Varies
Silver Creek							
Reach 1	03,05	-1.4	-0.4	+0.6	015	A3	Varies

[1]Flood Insurance Rate Map Panel
[2]Weighted Average
[3]Rounded to the nearest foot - see map

TABLE 3

FEDERAL EMERGENCY MANAGEMENT AGENCY

TOWNSHIP OF UNION, PA
(SNYDER CO.)

FLOOD INSURANCE ZONE DATA

SUSQUEHANNA RIVER, MIDDLE CREEK AND SILVER CREEK

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5.2 Flood Hazard Factors

The FHF is the FEMA device used to correlate flood information with insurance rate tables. Correlations between property damage from floods and their FHFs are used to set actuarial insurance premium rate tables based on FHFs from 005 to 200.

The FHF for a reach is the average weighted difference between the 10- and 100-year flood water-surface elevations expressed to the nearest 0.5 foot, and shown as a three-digit code. For example, if the difference between water-surface elevations of the 10- and 100-year floods is 0.7 foot, the FHF is 005; if the difference is 1.4 feet, the FHF is 015; if the difference is 5.0 feet, the FHF is 050. When the difference between the 10- and 100-year water-surface elevations is greater than 10.0 feet, accuracy for the FHF is to the nearest foot.

5.3 Flood Insurance Zones

After the determination of reaches and their respective FHFs, the entire incorporated area of the Township of Union was divided into zones, each having a specific flood potential or hazard. Each zone was assigned one of the following flood insurance zone designations:

Zone A:	Special Flood Hazard Areas inundated by the 100-year flood, determined by approximate methods; no base flood elevations shown or FHFs determined.
Zones A3, A12, and A13:	Special Flood Hazard Areas inundated by the 100-year flood, determined by detailed methods; base flood elevations shown, and zones subdivided according to FHF.
Zone B:	Areas between the Special Flood Hazard Area and the limits of the 500-year flood, including areas of the 500-year flood plain that are protected from the 100-year flood by dike, levee, or other water control structure; also, areas subject to certain types of 100-year shallow flooding where depths are less than 1.0 foot; and areas subject to 100-year flooding from sources with drainage areas less than 1 square mile. Zone B is not subdivided.
Zone C:	Areas of minimal flooding.

Table 3, "Flood Insurance Zone Data," summarizes the flood elevation differences, FHFs, flood insurance zones, and base flood elevations for the flooding sources studied in detail in the Township of Union.

5.4 Flood Insurance Rate Map Description

The Flood Insurance Rate Map for the Township of Union is, for insurance purposes, the principal result of the Flood Insurance Study. This map (published separately) contains the official delineation of flood insurance zones and base flood elevation lines. Base flood elevation lines show the locations of the expected whole-foot water-surface elevations of the base (100-year) flood. This map is developed in accordance with the latest flood insurance map preparation guidelines published by the FEMA.

6.0 OTHER STUDIES

Flood Insurance Studies for the Townships of Jackson and Lower Augusta have been completed (References 8 and 22). The results of this study are in exact agreement with the results of those studies. Flood Insurance Studies for the Townships of Penn, Chapman, and Lower Mahanoy are currently being prepared (References 10, 23, and 24). The results of those studies will be in exact agreement with the results of this study.

This study is authoritative for purposes of the Flood Insurance Program, and the data presented here either supersede or are compatible with previous determinations.

7.0 LOCATION OF DATA

Survey, hydrologic, hydraulic, and other pertinent data used in this study can be obtained by contacting the office of the Insurance and Mitigation Division of the Federal Emergency Management Agency, Regional Director, Region III Office, Curtis Building, Room 700, Sixth and Walnut Streets, Philadelphia, Pennsylvania 19106.

8.0 BIBLIOGRAPHY AND REFERENCES

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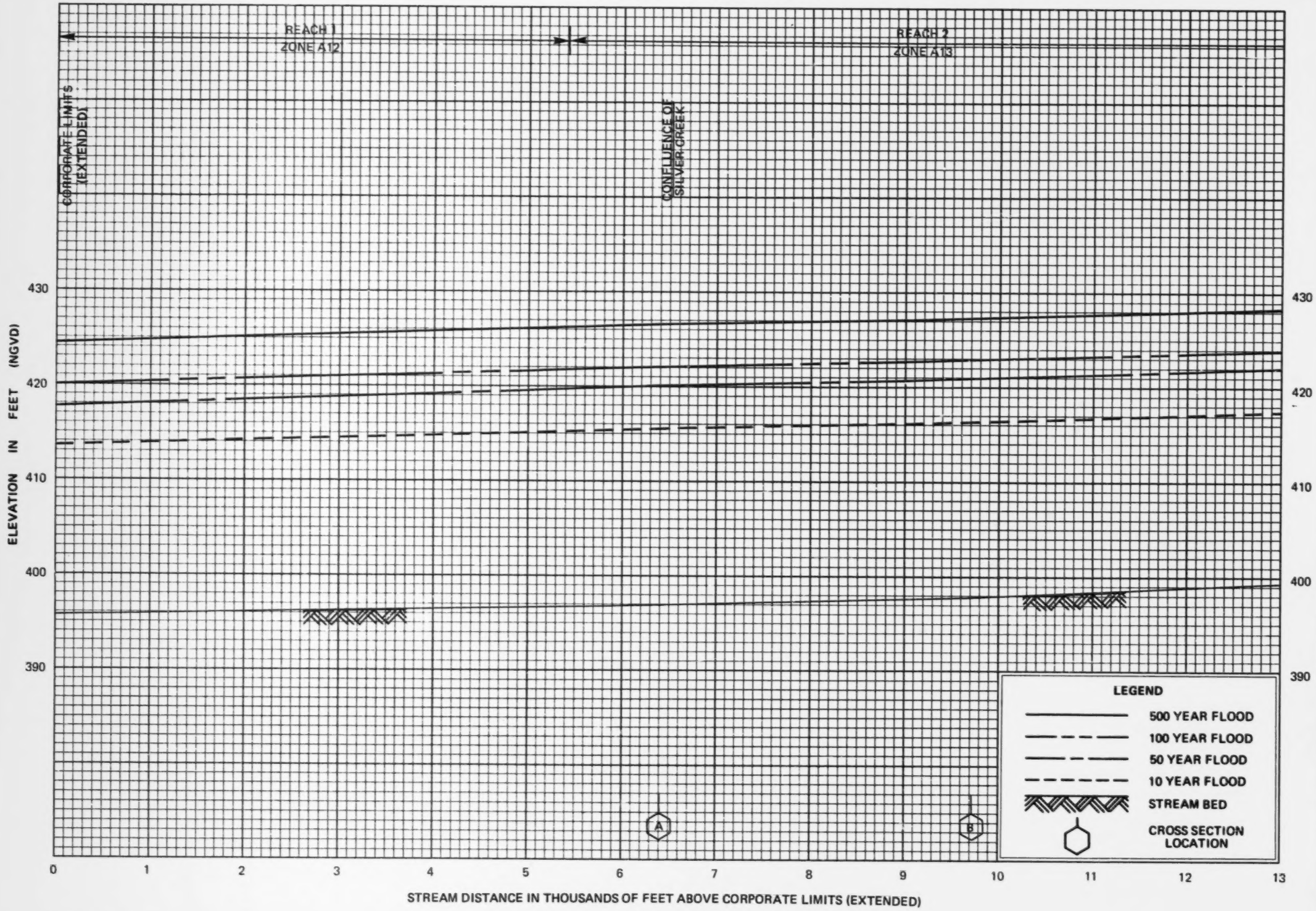


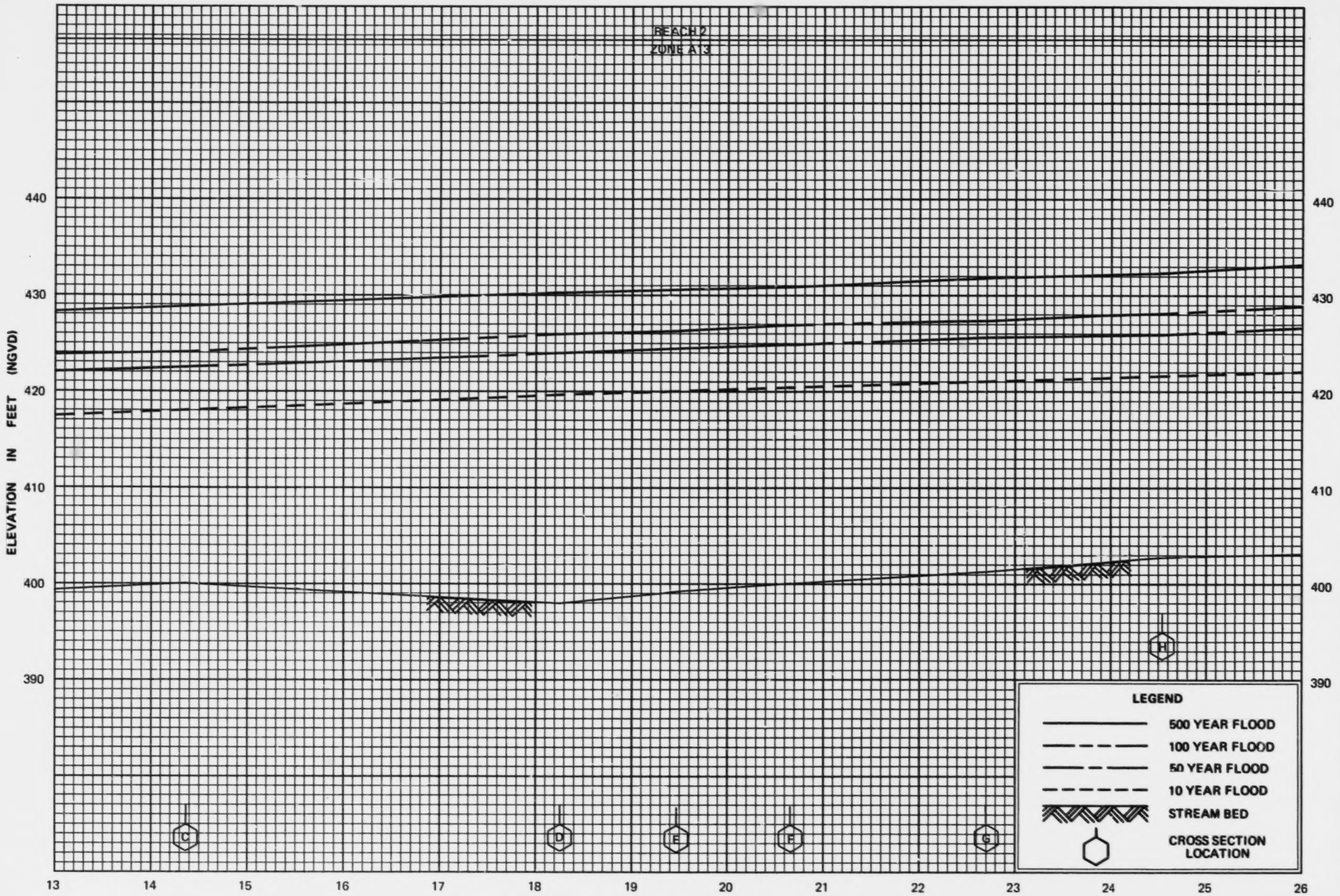
FLOOD PROFILES

SUSQUEHANNA RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

TOWNSHIP OF UNION, PA
(SNYDER CO.)

01P



FLOOD PROFILES

SUSQUEHANNA RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

TOWNSHIP OF UNION, PA
(SNYDER CO.)

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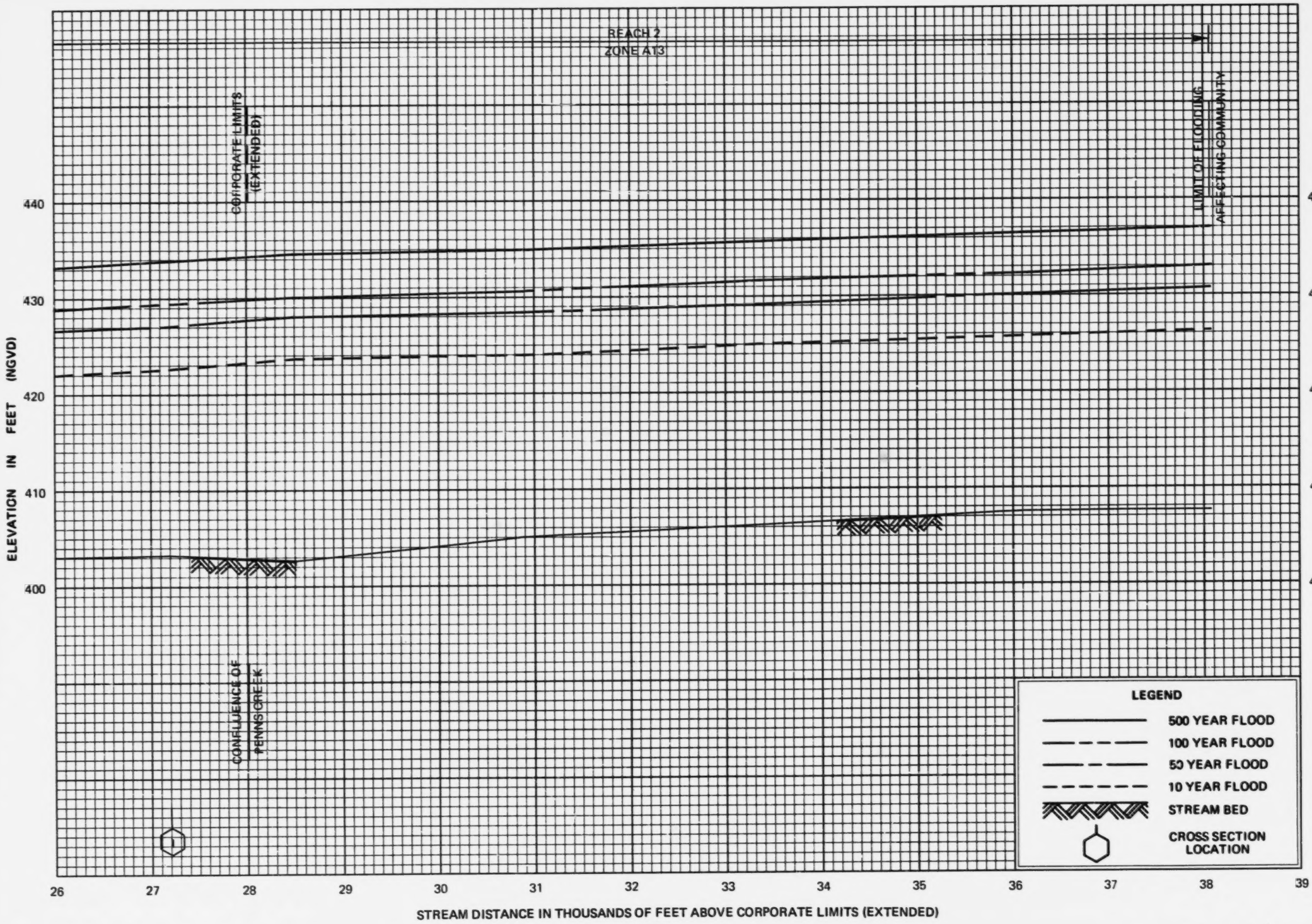

FLOOD PROFILES

SUSQUEHANNA RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

TOWNSHIP OF UNION, PA
(SNYDER CO.)

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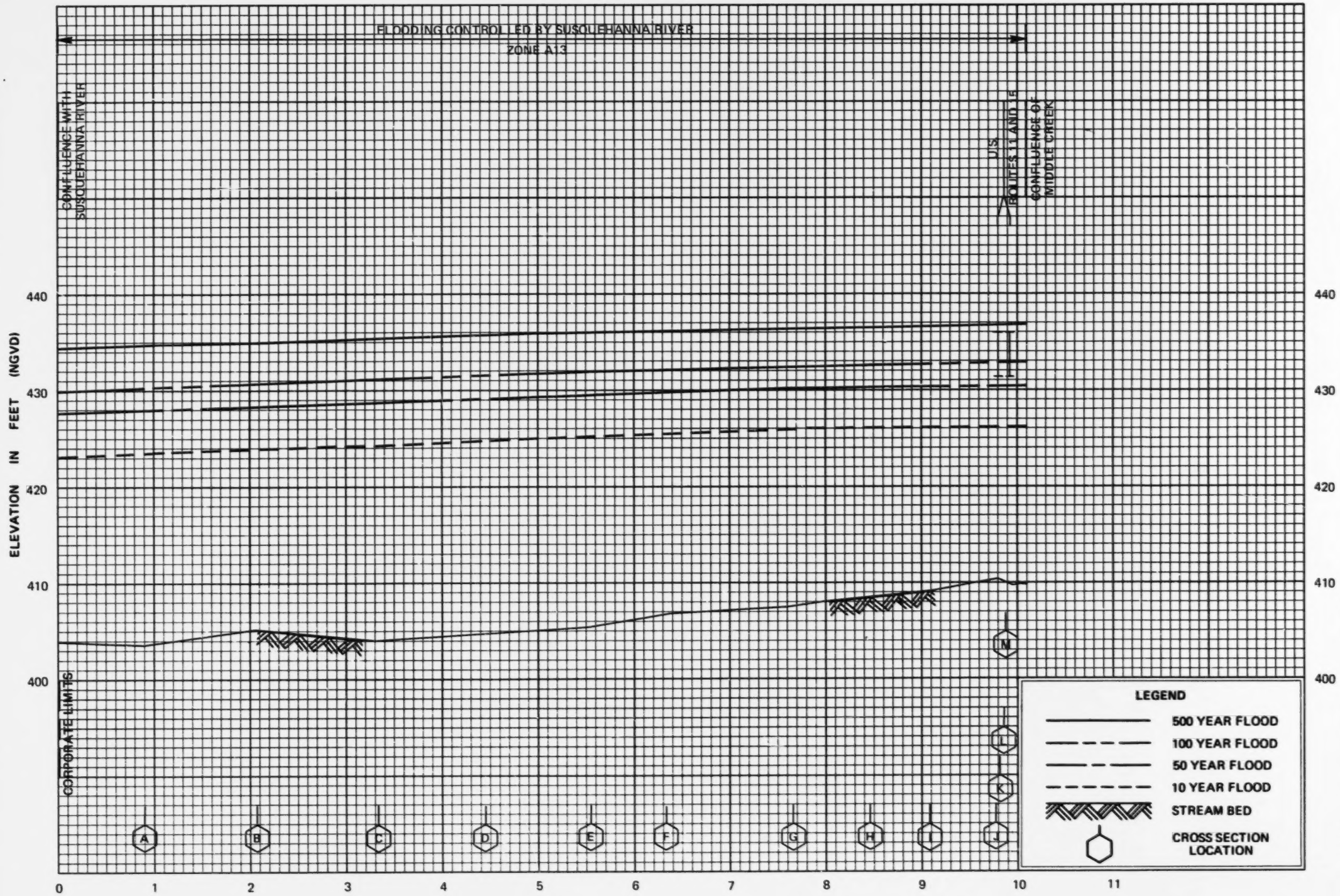

FLOOD PROFILES

PENNS CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

TOWNSHIP OF UNION, PA
(SNYDER CO.)

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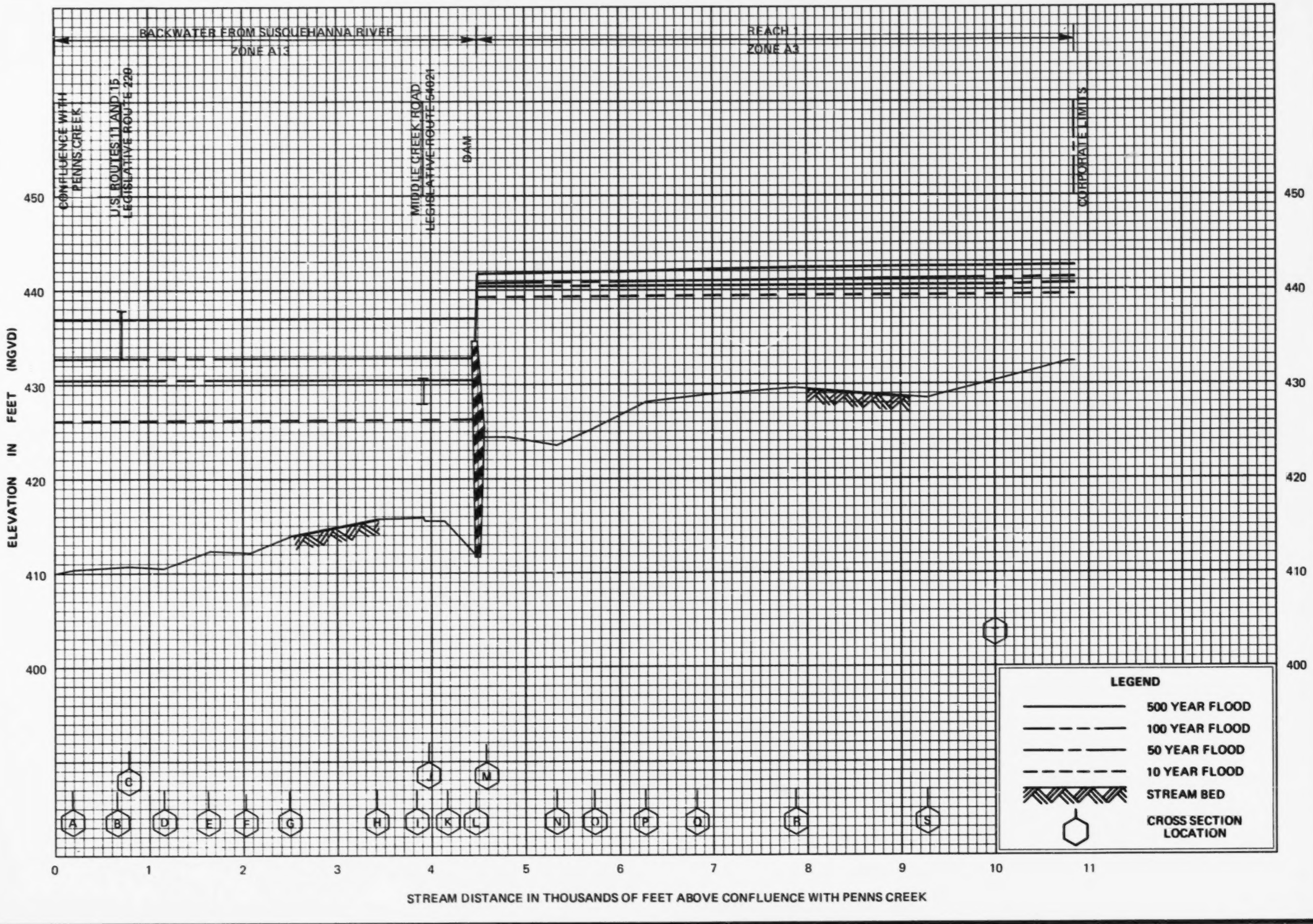

FLOOD PROFILES

MIDDLE CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

TOWNSHIP OF UNION, PA
(SNYDER CO.)

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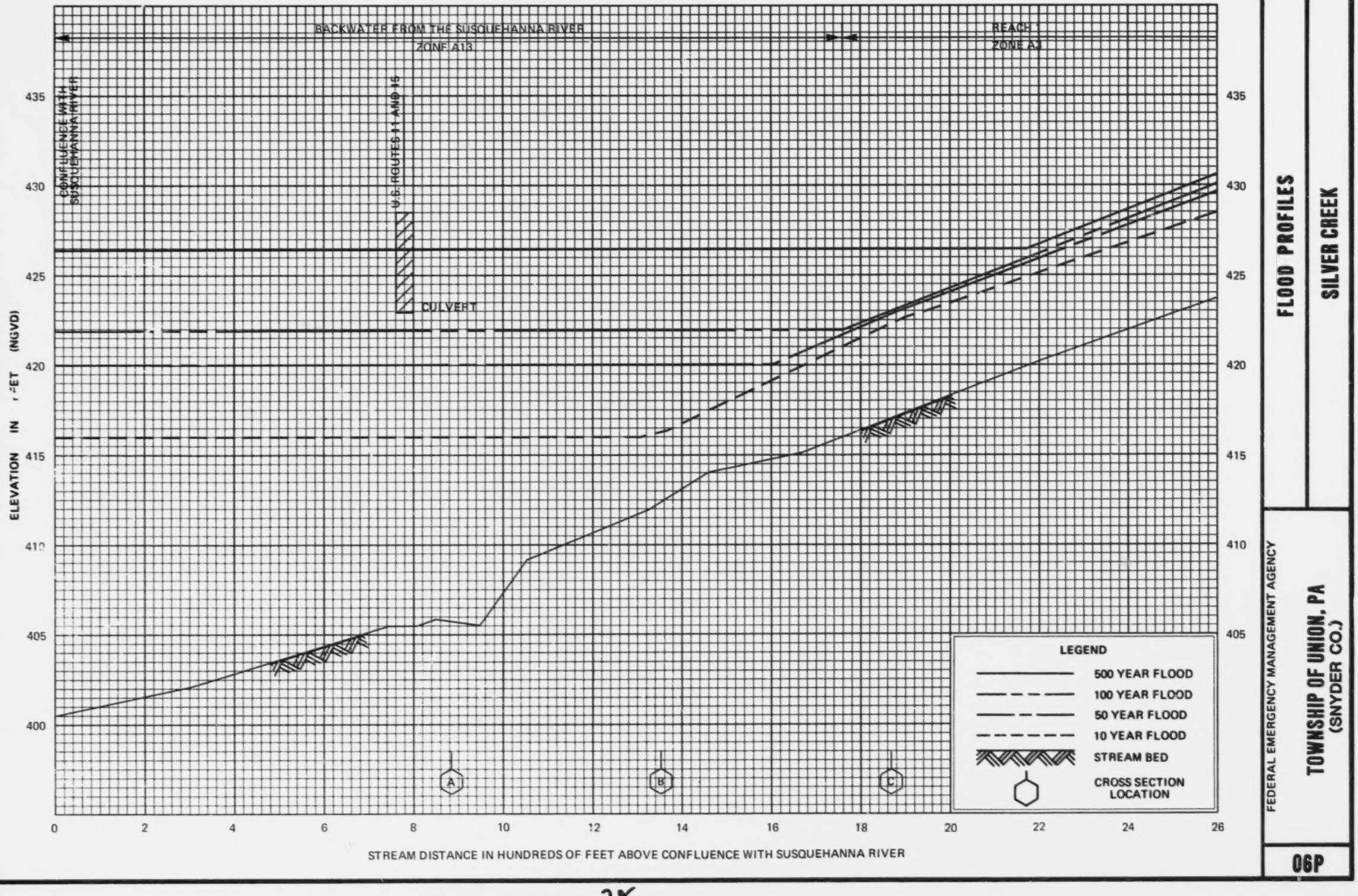

FLOOD PROFILES

SILVER CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

TOWNSHIP OF UNION, PA
(SNYDER CO.)

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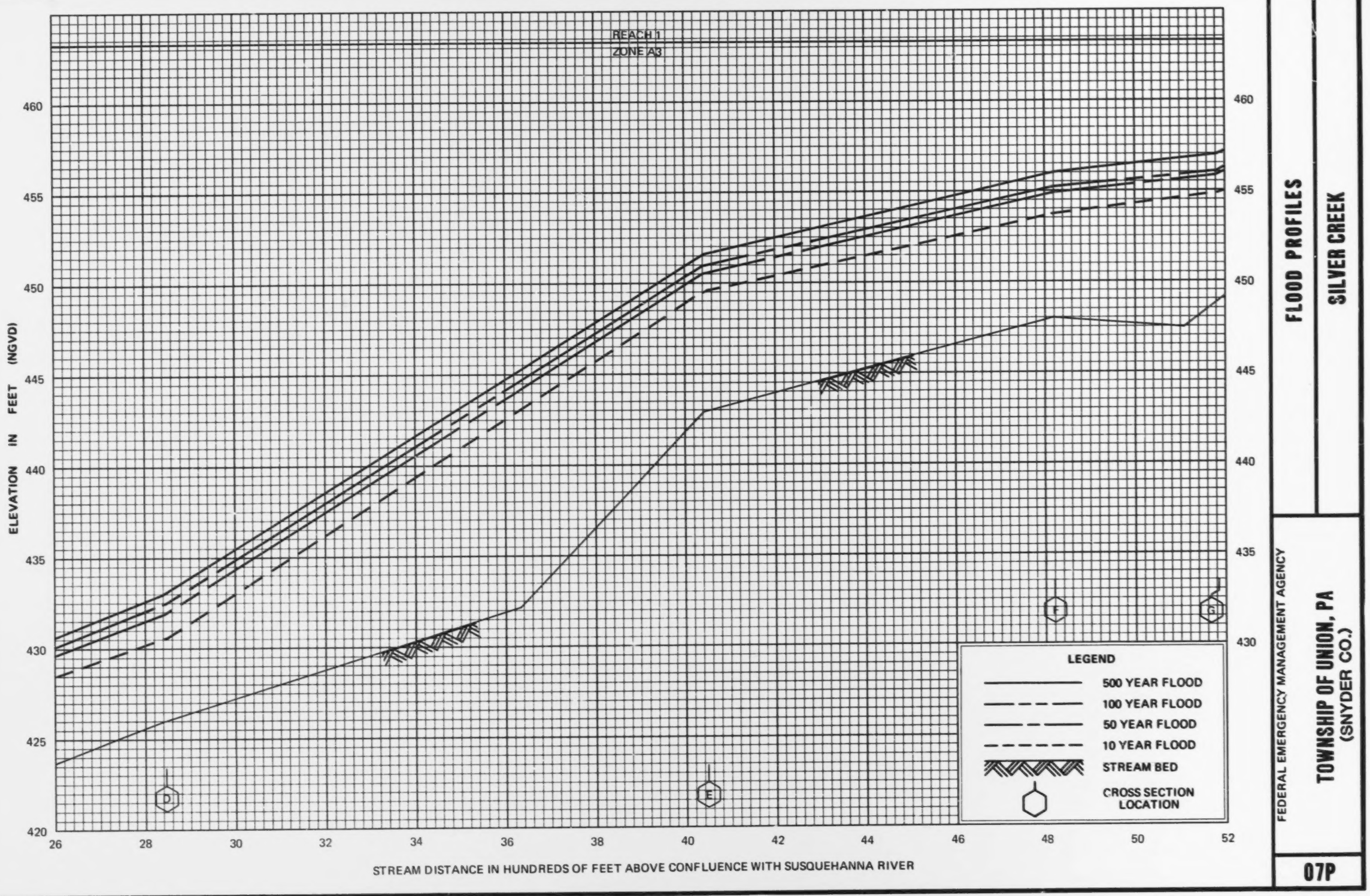

FLOOD PROFILES

SILVER CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

TOWNSHIP OF UNION, PA
(SNYDER CO.)

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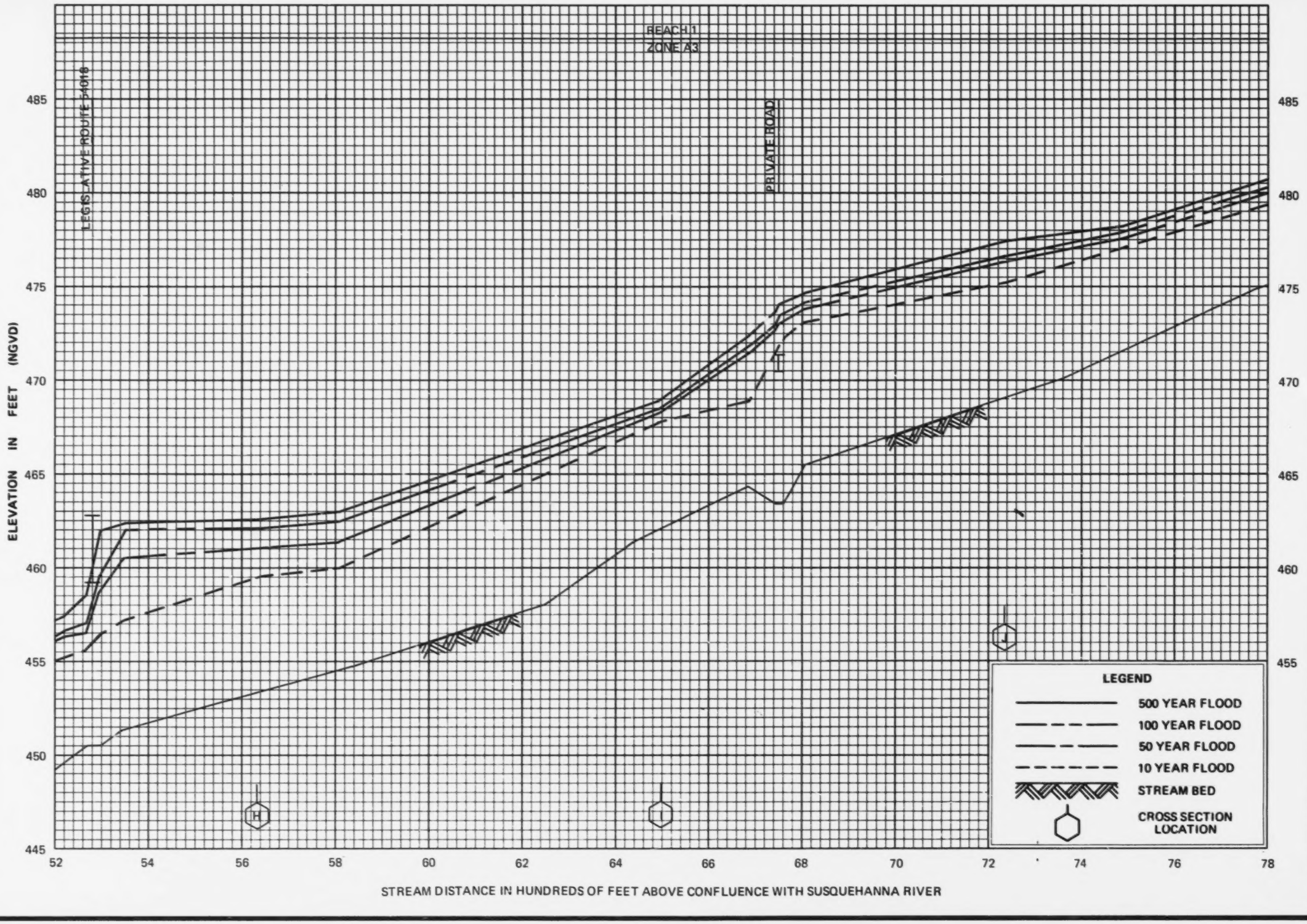

FLOOD PROFILES

SILVER CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

TOWNSHIP OF UNION, PA
(SNYDER CO.)

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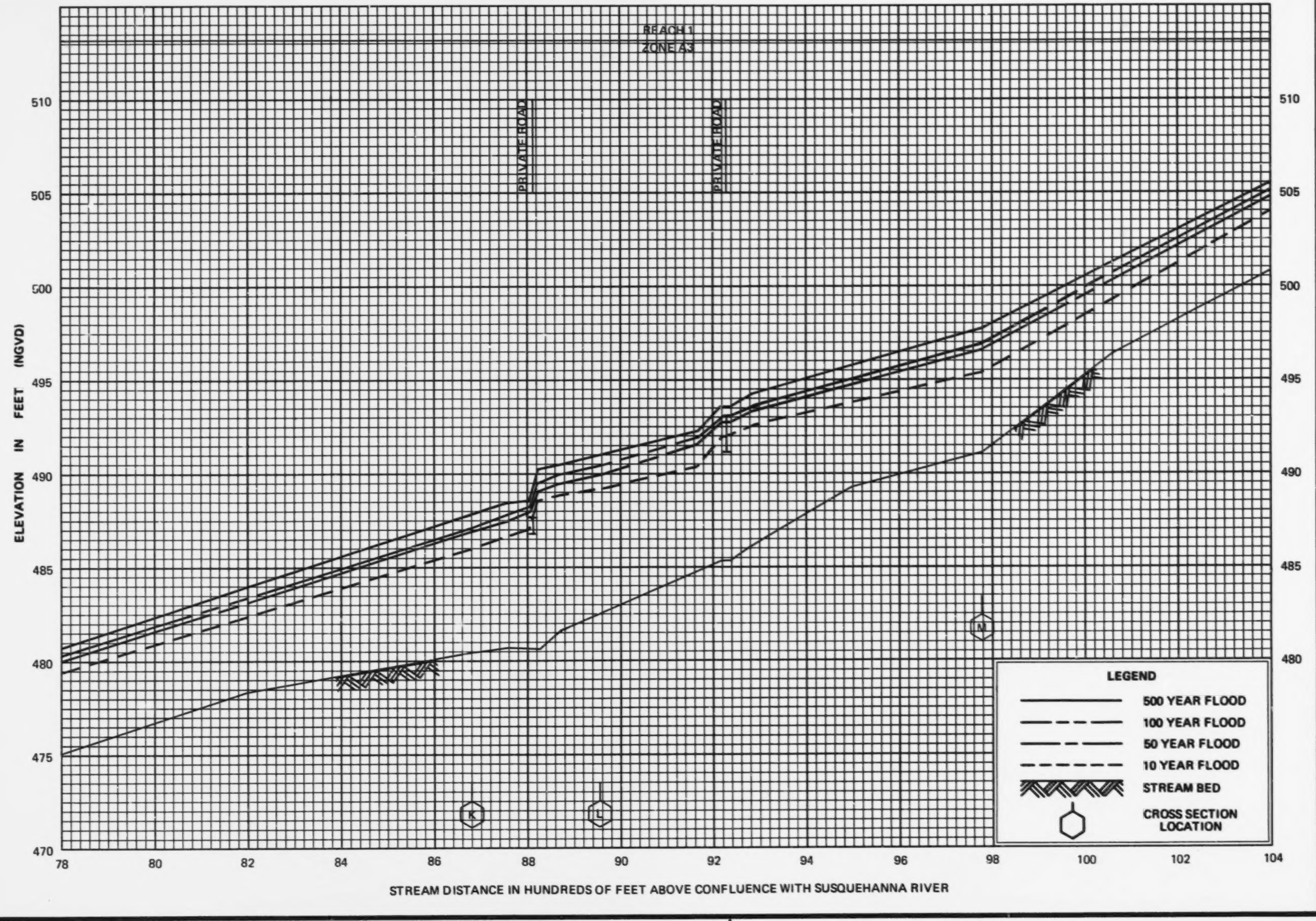

FLOOD PROFILES

SILVER CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

TOWNSHIP OF UNION, PA
(SNYDER CO.)

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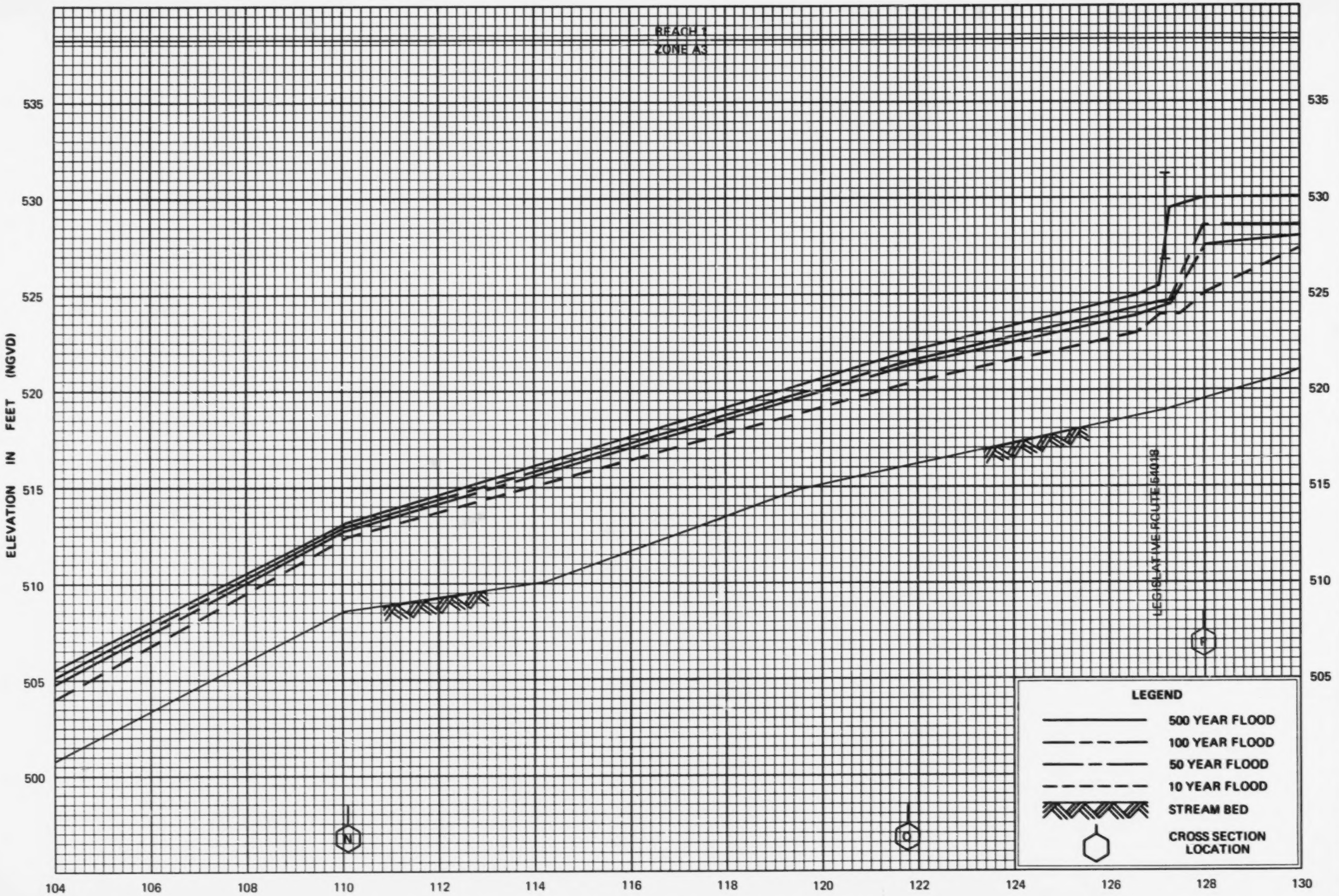

FLOOD PROFILES

SILVER CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

TOWNSHIP OF UNION, PA
(SNYDER CO.)

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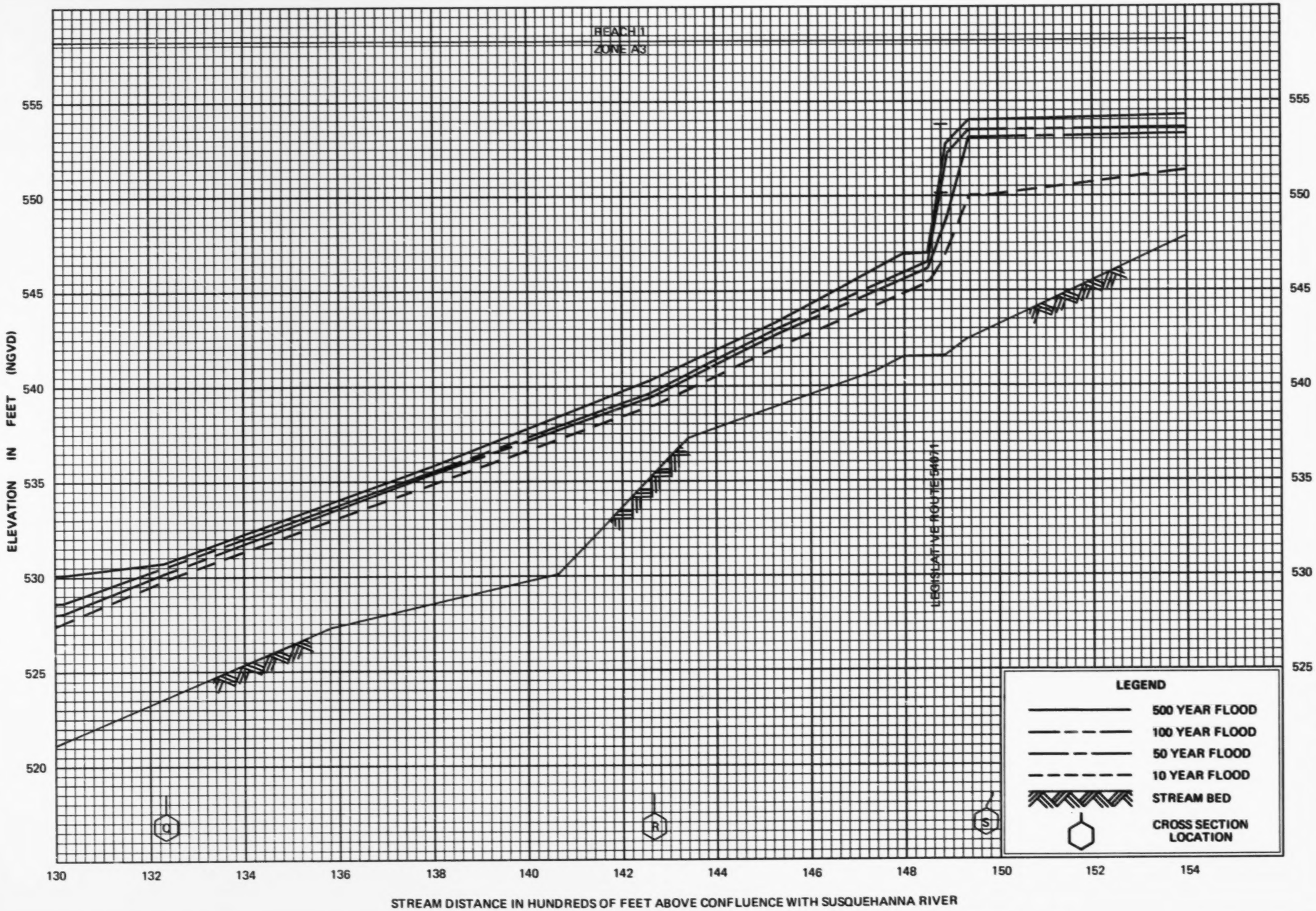

FLOOD PROFILES

SILVER CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

TOWNSHIP OF UNION, PA
(SNYDER CO.)

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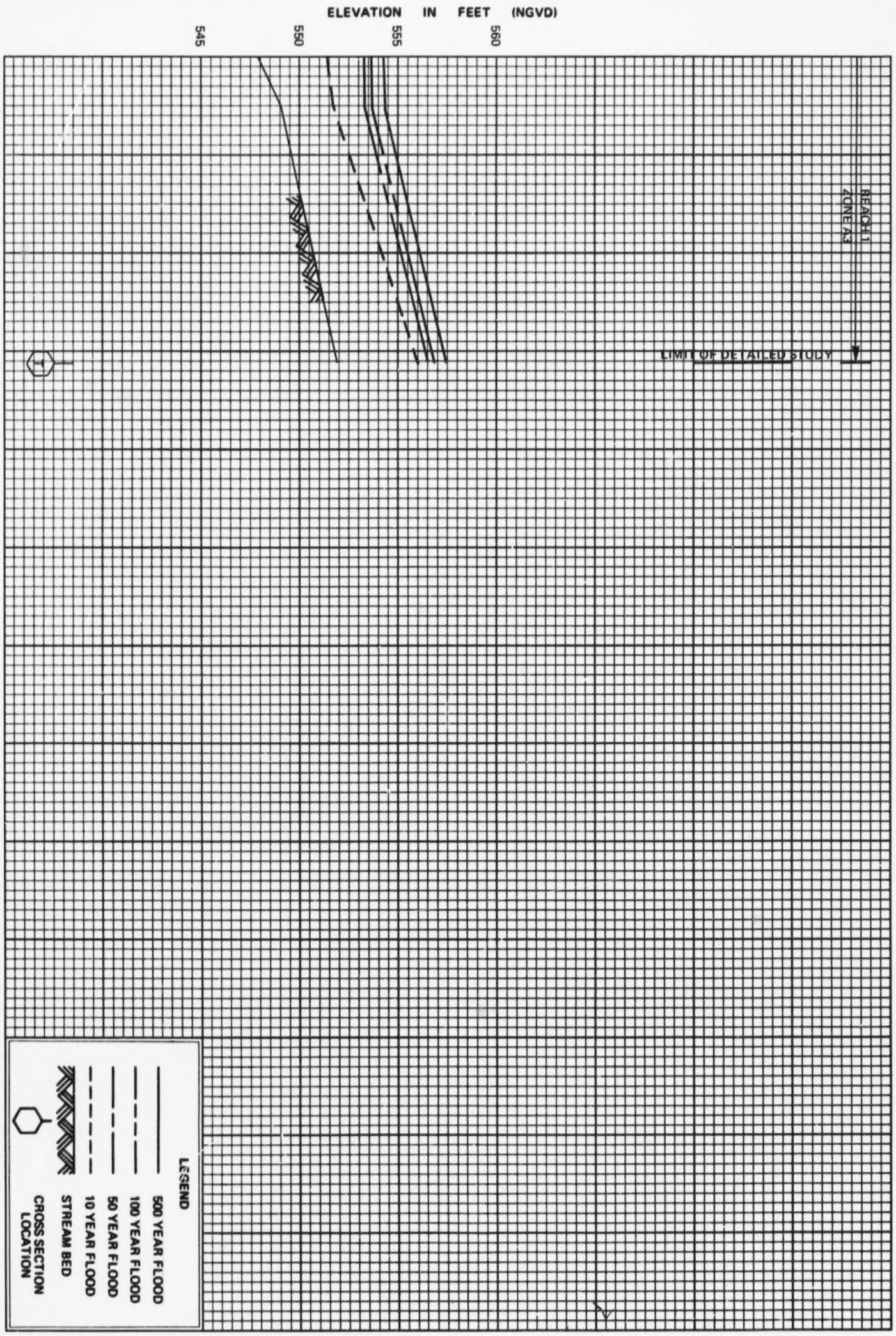

STREAM DISTANCE IN HUNDREDS OF FEET ABOVE CONFLUENCE WITH SUSQUEHANNA RIVER

34

12P

FEDERAL EMERGENCY MANAGEMENT AGENCY

TOWNSHIP OF UNION, PA
(SNYDER CO.)

FLOOD PROFILES

SILVER CREEK